

ABSTRACT

Soft decision sections (503, 506) provisionally decide each modulated signal (502, 505) separated using an inverse matrix calculation of a channel fluctuation matrix at separation section (501). Signal point reduction sections (508, 510, 514, 516) reduce candidate signal points of a multiplexed modulated signal using the provisional decision results (504, 507). Soft decision sections (512, 518) make a correct decision using the reduced candidate signal points and obtain received data (RA, RB) of each modulated signal. This allows received data RA, RB with a good error rate characteristic to be obtained with a relatively small number of calculations without reducing data transmission efficiency.

FIG.1

100 MULTI-ANTENNA COMMUNICATION SYSTEM

111 TRANSMISSION SECTION

121 RECEPTION SECTION

5

FIG.2

110 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

202A MODULATION SECTION

10 203A SPREADING SECTION

204A RADIO SECTION

201B CODING SECTION

202B MODULATION SECTION

203B SPREADING SECTION

15 204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.3

201 CHANNEL ESTIMATION SYMBOL

20 202 DATA SYMBOL

TIME

FIG.4

120 MULTI-ANTENNA RECEPTION APPARATUS

25 404 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A

5 403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B

402-1 DESPREADING SECTION

402-2 DESPREADING SECTION

401-1 RADIO SECTION

10 401-2 RADIO SECTION

FIG.5

404 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

15 518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

20 508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

506 SOFT DECISION SECTION

514 SIGNAL POINT REDUCTION SECTION

25 516 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

505 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

5 FIG.6

503 SOFT DECISION SECTION

603 DECISION SECTION

601 SOFT DECISION VALUE CALCULATION SECTION

10 FIG.11

1100 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

15 511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

20 1101 SOFT DECISION SECTION

514 SIGNAL POINT REDUCTION SECTION

516 SIGNAL POINT REDUCTION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

25

FIG.12

1200 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION
 518 SOFT DECISION SECTION
 509 NUMBER OF SIGNAL POINTS: 4
 511 NUMBER OF SIGNAL POINTS: 4
 5 515 NUMBER OF SIGNAL POINTS: 4
 517 NUMBER OF SIGNAL POINTS: 4
 1201 SIGNAL POINT REDUCTION SECTION
 1202 SIGNAL POINT REDUCTION SECTION
 503 SOFT DECISION SECTION
 10 514 SIGNAL POINT REDUCTION SECTION
 516 SIGNAL POINT REDUCTION SECTION
 502 NUMBER OF SIGNAL POINTS: 4
 501 SEPARATION SECTION
 h12 NUMBER OF SIGNAL POINTS: 16
 15 R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.13

1300 SIGNAL PROCESSING SECTION
 512 SOFT DECISION SECTION
 20 518 SOFT DECISION SECTION
 509 NUMBER OF SIGNAL POINTS: 4
 511 NUMBER OF SIGNAL POINTS: 4
 515 NUMBER OF SIGNAL POINTS: 4
 517 NUMBER OF SIGNAL POINTS: 4
 25 1301 SIGNAL POINT REDUCTION SECTION
 1302 SIGNAL POINT REDUCTION SECTION
 503 SOFT DECISION SECTION

- 506 SOFT DECISION SECTION
- 1303 SIGNAL POINT REDUCTION SECTION
- 1304 SIGNAL POINT REDUCTION SECTION
- 502 NUMBER OF SIGNAL POINTS: 4
- 5 505 NUMBER OF SIGNAL POINTS: 4
- 501 SEPARATION SECTION
- h12 NUMBER OF SIGNAL POINTS: 16
- R2-2 NUMBER OF SIGNAL POINTS: 16
- 10 FIG.14
- MODULATED SIGNAL A
- ST1A SOFT DECISION
- DIGITAL SIGNAL OF MODULATED SIGNAL B
- ST2A SIGNAL POINT REDUCTION
- 15 ST3A SOFT DECISION
- DIGITAL SIGNAL OF MODULATED SIGNAL B
- ST4A SIGNAL POINT REDUCTION
- ST5A SOFT DECISION
- MODULATED SIGNAL B
- 20 ST1B SOFT DECISION
- DIGITAL SIGNAL OF MODULATED SIGNAL A
- ST2B SIGNAL POINT REDUCTION
- ST3B SOFT DECISION
- DIGITAL SIGNAL OF MODULATED SIGNAL A
- 25 ST4B SIGNAL POINT REDUCTION
- ST5B SOFT DECISION
- FIRST SOFT DECISION

SECOND SOFT DECISION

THIRD SOFT DECISION

FIG.15

- 5 1 FRAME OF MODULATED SIGNAL A
- 1 FRAME OF MODULATED SIGNAL B
- FIRST ERROR CORRECTION
- REFLECTS FIRST ERROR CORRECTION AND REDUCES NUMBER OF STATES
- 10 1 FRAME OF MODULATED SIGNAL A
- 1 FRAME OF MODULATED SIGNAL B
- SECOND ERROR CORRECTION

FIG.16

- 15 MODULATED SIGNAL A
- GOOD
- RECEPTION QUALITY
- BAD
- C/N (CARRIER POWER VS. NOISE POWER RATIO)
- 20 BAD
- RECEPTION FIELD INTENSITY
- GOOD
- 1601 AFTER FIRST SOFT DECISION RESULT
- 1602 AFTER SECOND SOFT DECISION RESULT
- 25 1603 AFTER THIRD SOFT DECISION RESULT
- 1604 AFTER FOURTH SOFT DECISION RESULT
- MODULATED SIGNAL B

GOOD

RECEPTION QUALITY

BAD.

FOR C/N (CARRIER POWER VS. NOISE POWER RATIO)

5 BAD

RECEPTION FIELD INTENSITY

GOOD

1605 AFTER FIRST SOFT DECISION RESULT

1606 AFTER SECOND SOFT DECISION RESULT

10 1607 AFTER THIRD SOFT DECISION RESULT

1608 AFTER FOURTH SOFT DECISION RESULT

FIG.17

1700 SIGNAL PROCESSING SECTION

15 512 SOFT DECISION SECTION

518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

20 517 NUMBER OF SIGNAL POINTS: 4

1701 SIGNAL POINT REDUCTION SECTION

1702 SIGNAL POINT REDUCTION SECTION

1705 SOFT DECISION SECTION

1703 SIGNAL POINT REDUCTION SECTION

25 1704 SIGNAL POINT REDUCTION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.18

1800 SIGNAL PROCESSING SECTION

512 SOFT DECISION SECTION

5 518 SOFT DECISION SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

10 1801 SIGNAL POINT REDUCTION SECTION

1802 SIGNAL POINT REDUCTION SECTION

503 SOFT DECISION SECTION

1803 SIGNAL POINT REDUCTION SECTION

1804 SIGNAL POINT REDUCTION SECTION

15 502 NUMBER OF SIGNAL POINTS: 4

501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

20 FIG.19

MODULATED SIGNAL A

FIRST SOFT DECISION

ST10A FIRST SOFT DECISION

DIGITAL SIGNAL OF SPREADING SIGNAL B

25 ST11A SIGNAL POINT REDUCTION

THIRD SOFT DECISION

ST12A SOFT DECISION

DIGITAL SIGNAL OF SPREAD SIGNAL A

MODULATED SIGNAL B

DIGITAL SIGNAL OF SPREAD SIGNAL A

5 ST10B SIGNAL POINT REDUCTION

ST11B SOFT DECISION

SECOND SOFT DECISION

FIG.20

10 MODULATED SIGNAL A

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

15 BAD

RECEPTION FIELD INTENSITY

GOOD

2001 AFTER FIRST SOFT DECISION RESULT

2003 AFTER THIRD SOFT DECISION RESULT

20

MODULATED SIGNAL B

GOOD

RECEPTION QUALITY

BAD

25 C/N (CARRIER POWER VS. NOISE POWER RATIO)

BAD

RECEPTION FIELD INTENSITY

GOOD

2006 AFTER SECOND SOFT DECISION RESULT

2008 AFTER FOURTH SOFT DECISION RESULT

5 FIG.22

GOOD

RECEPTION QUALITY

BAD

C/N (CARRIER POWER VS. NOISE POWER RATIO)

10 BAD

RECEPTION FIELD INTENSITY

GOOD

FIG.23

15 2300 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

203A SPREADING SECTION

20 204A RADIO SECTION

201B CODING SECTION

2301B INTERLEAVER

202B MODULATION SECTION

203B SPREADING SECTION

25 204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.24

- 2400 SIGNAL PROCESSING SECTION
 - 2405A INTERLEAVER
 - 2405B INTERLEAVER
- 5 512 SOFT DECISION SECTION
 - 518 SOFT DECISION SECTION
 - 2403A DEINTERLEAVER
 - 2404A DEINTERLEAVER
 - 2403B DEINTERLEAVER
- 10 2404B DEINTERLEAVER
 - 2402A INTERLEAVER
 - 2402B INTERLEAVER
- 1301 SIGNAL POINT REDUCTION SECTION
- 1302 SIGNAL POINT REDUCTION SECTION
- 15 503 SOFT DECISION SECTION
 - 506 SOFT DECISION SECTION
 - 1303 SIGNAL POINT REDUCTION SECTION
 - 1304 SIGNAL POINT REDUCTION SECTION
- 2401A DEINTERLEAVER
- 20 2401B DEINTERLEAVER
- 501 SEPARATION SECTION

FIG.25

(A)

- 25 MODULATED SIGNAL A
 - CORRECT SYMBOL
 - CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

5 WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

10 REDUCTION OF SIGNAL POINTS

(B)

MODULATED SIGNAL B

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

15 WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

20 CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

25 FIG. 26

(A)

MODULATED SIGNAL A

- CORRECT SYMBOL
CORRECT SYMBOL
WRONG SYMBOL
WRONG SYMBOL
5 WRONG SYMBOL
WRONG SYMBOL
WRONG SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
10 CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
TIME
15 REDUCTION OF SIGNAL POINTS
(B)
MODULATED SIGNAL B
CORRECT SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION
20 CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
25 WRONG SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

TIME

5 DECODING

FIG.27

IDENTICAL INTERLEAVING: NO ITERATIVE DECODING

IDENTICAL INTERLEAVING: ITERATIVE DECODING ONCE

10 IDENTICAL INTERLEAVING: ITERATIVE DECODING FIVE TIMES

DIFFERENT INTERLEAVING: NO ITERATIVE DECODING

DIFFERENT INTERLEAVING: ITERATIVE DECODING ONCE

DIFFERENT INTERLEAVING: ITERATIVE DECODING FIVE TIMES

15 FIG.28

(A)

BEFORE INTERLEAVING

DATA 1

DATA 2

20 DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

25 DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

5 DATA 190

DATA 195

DATA 200

(B)

10 BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

15 DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

20 DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

25 DATA 184

DATA 192

DATA 200

FIG. 29

(A)

BEFORE INTERLEAVING

5 DATA 1
DATA 2
DATA 3
DATA 4
DATA 197
10 DATA 198
DATA 199
DATA 200

AFTER INTERLEAVING

DATA 1
15 DATA 6
DATA 11
DATA 16
DATA 185
DATA 190
20 DATA 195
DATA 200

(B)

DATA 1
DATA 6
25 DATA 11
DATA 16
DATA 185

DATA 190

DATA 195

DATA 200

FREQUENCY OR TIME

5 (C)

DATA 185

DATA 190

DATA 195

DATA 200

10 DATA 1

DATA 6

DATA 11

DATA 16

FREQUENCY OR TIME

15

FIG.30

2700 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

202A MODULATION SECTION

20 204A RADIO SECTION

201B CODING SECTION

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

25

FIG.31

(A)

MODULATED SIGNAL A

TRANSMISSION SIGNAL

CODING IN FREQUENCY AXIS DIRECTION

CODING IN TIME AXIS DIRECTION

5 FREQUENCY

CARRIER 1

CARRIER 2

CARRIER 3

CARRIER 4

10 CARRIER 5

TIME

TIME 1

TIME 2

TIME 3

15 TIME 4

TIME 5

TIME 6

TIME 7

TIME 8

20 TIME 9

(B)

MODULATED SIGNAL B

TRANSMISSION SIGNAL

CODING IN FREQUENCY AXIS DIRECTION

25 CODING IN TIME AXIS DIRECTION

CARRIER 1

CARRIER 2

CARRIER 3
CARRIER 4
CARRIER 5
FREQUENCY
5 TIME
TIME 1
TIME 2
TIME 3
TIME 4
10 TIME 5
TIME 6
TIME 7
TIME 8
TIME 9
15 PILOT SYMBOL
DATA SYMBOL

FIG.32

2900 MULTI-ANTENNA TRANSMISSION APPARATUS
20 201A CODING SECTION
2301A INTERLEAVER
202A MODULATION SECTION
204A RADIO SECTION
201B CODING SECTION
25 2301B INTERLEAVER
202B MODULATION SECTION
204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.33

3000 MULTI-ANTENNA RECEPTION APPARATUS

5 3002 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B10 403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B

401-1 RADIO SECTION

15 401-2 RADIO SECTION

FIG.34

(A)

MODULATED SIGNAL A.

20 RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

25 WRONG SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

5 RIGHT SYMBOL

(B)

MINIMUM VALUE OF PATH METRIC
TIME

(C)

10 MODULATED SIGNAL B

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

15 WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

RIGHT SYMBOL

20 WRONG SYMBOL

RIGHT SYMBOL

RIGHT SYMBOL

WRONG SYMBOL

25 (D)

MULTIPLIER

TIME

DECODING

FIG.35

MODULATED SIGNAL A

5 TRANSMISSION SIGNAL
3301 CHANNEL ESTIMATION SYMBOL
3302 DATA SYMBOL
3303 STBC SYMBOL
3304 DATA SYMBOL
10 3305 STBC SYMBOL
3306 DATA SYMBOL
TIME
4 SYMBOLS
2 SYMBOLS
15 4 SYMBOLS
2 SYMBOLS
4 SYMBOLS

MODULATED SIGNAL B

TRANSMISSION SIGNAL

20 3307 CHANNEL ESTIMATION SYMBOL
3308 DATA SYMBOL
3309 STBC SYMBOL
3310 DATA SYMBOL
3311 STBC SYMBOL
25 3312 DATA SYMBOL
TIME

FIG.36

TIME t

TIME t

TIME $t+1$

5 TIME $t+1$

TRANSMISSION SECTION

RECEPTION SECTION

TIME t

TIME $t+1$

10

FIG.37

202A(202B)

3501 DATA SYMBOL SIGNAL GENERATION SECTION

3502 STBC SYMBOL SIGNAL GENERATION SECTION

15 3503 CHANNEL ESTIMATION SYMBOL SIGNAL GENERATION
SECTION

3508 SIGNAL SELECTION SECTION

FIG.38

20 3600 SIGNAL PROCESSING SECTION

4114 DECODING SECTION

4115 DECODING SECTION

4110 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

4112 DATA SYMBOL BRANCH METRIC CALCULATION SECTION

25 508 SIGNAL POINT REDUCTION SECTION

510 SIGNAL POINT REDUCTION SECTION

4108 DECODING SECTION

4104 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 4109 DECODING SECTION
 4106 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 514 SIGNAL POINT REDUCTION SECTION
 5 516 SIGNAL POINT REDUCTION SECTION
 4101 STBC SYMBOL BRANCH METRIC CALCULATION SECTION
 501 SEPARATION SECTION

FIG.39

10 3700 SIGNAL PROCESSING SECTION
 4114 DECODING SECTION
 4115 DECODING SECTION
 4110 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 4112 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 15 508 SIGNAL POINT REDUCTION SECTION
 510 SIGNAL POINT REDUCTION SECTION
 4108 DECODING SECTION
 4104 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 4109 DECODING SECTION
 20 4106 DATA SYMBOL BRANCH METRIC CALCULATION SECTION
 514 SIGNAL POINT REDUCTION SECTION
 516 SIGNAL POINT REDUCTION SECTION
 4101 STBC SYMBOL BRANCH METRIC CALCULATION SECTION
 501 SEPARATION SECTION

25

FIG.40

(A)

FRAME CONFIGURATION OF MODULATED SIGNAL A

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

5 STBC SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

10 STBC SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

(B)

15 MODULATED SIGNAL A

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

20 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

25 CORRECT SIGNAL

WRONG SYMBOL

WRONG SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

REDUCTION OF SIGNAL POINTS

5 (C)

MODULATED SIGNAL B

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

10 SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

15 SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

TIME

20 DECODING

FIG. 41

MODULATED SIGNAL A

MODULATED SIGNAL B

25 3701 DATA SYMBOL

3703 (I,Q) = (0,0) SYMBOL

3702 (I,Q) = (0,0) SYMBOL

3704 DATA SYMBOL

TIME

FIG.42

5 MODULATED SIGNAL A

MODULATED SIGNAL B

3801 KNOWN DATA SYMBOL

3802 KNOWN DATA SYMBOL

TIME

10

FIG.43

3501 DATA SYMBOL SIGNAL GENERATION SECTION

4001 SPECIAL SYMBOL SIGNAL GENERATION SECTION

3503 CHANNEL ESTIMATION SYMBOL SIGNAL GENERATION

15 SECTION

3508 SIGNAL SELECTION SECTION

FIG.44

(A)

20 FRAME CONFIGURATION OF MODULATED SIGNAL A

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

3601 SPECIAL SYMBOL

25 DATA SYMBOL

DATA SYMBOL

DATA SYMBOL

DATA SYMBOL
3602 SPECIAL SYMBOL
DATA SYMBOL
DATA SYMBOL
5 DATA SYMBOL
(B)
MODULATED SIGNAL A
WRONG SYMBOL
WRONG SYMBOL
10 CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
15 CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
WRONG SYMBOL
WRONG SYMBOL
20 TIME
REDUCTION OF SIGNAL POINTS
REDUCTION OF SIGNAL POINTS
REDUCTION OF SIGNAL POINTS
(C)
25 WRONG SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

5 CORRECT SIGNAL POINT SELECTION

SIGNAL POINT SELECTION UNNECESSARY

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

10 TIME

DECODING

FIG.45 .

(A)

15 CODED SYMBOL BLOCK

DATA SEQUENCE

AFTER INTERLEAVING

(B)

TIME

20 TRANSMISSION SEQUENCE

FIG.46

MODULATED SIGNAL A

4401 CHANNEL ESTIMATION SYMBOL

25 4402 DATA SYMBOL

4403 CHANNEL ESTIMATION SYMBOL

4404 DATA SYMBOL

4405 CHANNEL ESTIMATION SYMBOL
4406 DATA SYMBOL
TRANSMITTED BY AN1
TRANSMITTED BY AN1
5 TRANSMITTED BY AN2
MODULATED SIGNAL B
4407 CHANNEL ESTIMATION SYMBOL
4408 DATA SYMBOL
4409 CHANNEL ESTIMATION SYMBOL
10 4410 DATA SYMBOL
4411 CHANNEL ESTIMATION SYMBOL
4412 DATA SYMBOL
TRANSMITTED BY AN2
RELIABILITY OF BRANCH METRIC IS LOW
15 TRANSMISSION BY AN3
RELIABILITY OF BRANCH METRIC IS LOW
TRANSMISSION BY AN3
RELIABILITY OF BRANCH METRIC IS HIGH
TIME
20
FIG.47
4500 MULTI-ANTENNA TRANSMISSION APPARATUS
201A CODING SECTION
202A MODULATION SECTION
25 203A SPREADING SECTION
204A RADIO SECTION
201B CODING SECTION

202B MODULATION SECTION
203B SPREADING SECTION
204B RADIO SECTION
4501 ANTENNA SELECTION SECTION
5 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.49

4700 MULTI-ANTENNA TRANSMISSION APPARATUS
4701 SIGNAL SEPARATION SECTION
10 4704 CODING SECTION FOR (Sa0,Sa2)
4706 CODING SECTION FOR (Sa1,Sa3)
4708 INTERLEAVER (PATTERN X)
4710 INTERLEAVER (PATTERN Y)
202A MODULATION SECTION
15 203A SPREADING SECTION
204A RADIO SECTION
4712 SIGNAL SEPARATION SECTION
4715 CODING SECTION FOR (Sb0,Sb2)
4717 CODING SECTION FOR (Sb1,Sb3)
20 4719 INTERLEAVER (PATTERN X)
4721 INTERLEAVER (PATTERN Y)
202B MODULATION SECTION
203B SPREADING SECTION
204B RADIO SECTION
25 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.50

MODULATED SIGNAL A
BEFORE INTERLEAVING

DATA 1

DATA 2

5 DATA 3

DATA 4

DATA 197

DATA 198

DATA 199

10 DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

DATA 11

15 DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

20 BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

25 DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 9

5 DATA 17

DATA 25

DATA 176

DATA 184

DATA 192

10 DATA 200

MODULATED SIGNAL B

BEFORE INTERLEAVING

DATA 1

15 DATA 2

DATA 3

DATA 4

DATA 197

DATA 198

20 DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

DATA 6

25 DATA 11

DATA 16

DATA 185

DATA 190

DATA 195

DATA 200

BEFORE INTERLEAVING

5 DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

10 DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

15 DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

20 DATA 192

DATA 200

TIME

FIG.51

25 4900 SIGNAL PROCESSING SECTION

4903 DECODING SECTION (FOR Sa0, Sa3)

4906 DECODING SECTION (FOR Sb1, Sb3)

4908 INTERLEAVER (FOR Sa1, Sa3)
4909 INTERLEAVER (FOR Sb1, Sb3)
4918 INTERLEAVER (FOR Sb0, Sb2)
4917 INTERLEAVER (FOR Sa0, Sa2)
5 4912 DECODING SECTION (FOR Sa0, Sa2)
4906 DECODING SECTION (FOR Sb0, Sb2)
4902 DEINTERLEAVER (FOR Sa1, Sa3)
4905 DEINTERLEAVER (FOR Sb1, Sb3)
4911 DEINTERLEAVER (FOR Sa0, Sa2)
10 4914 DEINTERLEAVER (FOR Sb0, Sb2)
4901 LIKELIHOOD DECISION SECTION
4910 LIKELIHOOD DECISION SECTION
2402A INTERLEAVER (FOR Sa0, Sa2)
2402B INTERLEAVER (FOR Sb0, Sb2)
15 1301 SIGNAL POINT REDUCTION SECTION
1302 SIGNAL POINT REDUCTION SECTION
503 SOFT DECISION SECTION (FOR Sa0, Sa2)
506 SOFT DECISION SECTION (FOR Sb0, Sb2)
1303 SIGNAL POINT REDUCTION SECTION
20 1304 SIGNAL POINT REDUCTION SECTION
2401A DEINTERLEAVER (FOR Sa0, Sa2)
2401B DEINTERLEAVER (FOR Sb0, Sb2)
501 SEPARATION SECTION

25 FIG.52

REDUCTION OF SIGNAL POINTS

FIG.53

MODULATED SIGNAL A

MODULATED SIGNAL B

ST21A Sa0, Sa2, Sb0, Sb2 DECODING

5 ST22A SIGNAL POINT REDUCTION

ST23A Sa0, Sa2, Sb0, Sb2 DECODING

Sa0, Sa2, Sb0, Sb2 INFORMATION

Sa1, Sa3, Sb1, Sb3 INFORMATION

Sa0, Sa2, Sb0, Sb2 INFORMATION

10 Sa1, Sa3, Sb1, Sb3 INFORMATION

ST21B SIGNAL POINT REDUCTION

ST22B Sa1, Sa3, Sb1, Sb3 DECODING

ST23B SIGNAL POINT REDUCTION

ST24B Sa1, Sa3, Sb1, Sb3 DECODING

15 FIRST DECODING

SECOND DECODING

THIRD DECODING

FOURTH DECODING

20 FIG.54

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

25 WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

5

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

10 WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

15 CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

CORRECT SIGNAL POINT SELECTION

20 CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

25 CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION
TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

5 FIG.55

(A)

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

10 WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

15 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

20 CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

25 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

(B)

WRONG SIGNAL POINT SELECTION

5 CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

10 CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

15 Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.56

5400 MULTI-ANTENNA TRANSMISSION APPARATUS

5402 SIGNAL SEPARATION SECTION

20 5405 CODING SECTION

5407 INTERLEAVER (PATTERN X)

5409 SEPARATION SECTION

202A MODULATION SECTION

203A SPREADING SECTION

25 204A RADIO SECTION

5412 CODING SECTION

5415 INTERLEAVER (PATTERN Y)

5417 SEPARATION SECTION
202B MODULATION SECTION
203B SPREADING SECTION
204B RADIO SECTION
5 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG. 57

(A)

BEFORE INTERLEAVING

10 DATA 1
DATA 2
DATA 3
DATA 4
DATA 197

15 DATA 198
DATA 199
DATA 200

AFTER INTERLEAVING

DATA 1
20 DATA 6
DATA 11
DATA 16
DATA 185
DATA 190

25 DATA 195
DATA 200
DATA 1

DATA 11

DATA 185

DATA 195

DATA 6

5 DATA 16

DATA 190

DATA 200

(B)

BEFORE INTERLEAVING

10 DATA 1

DATA 2

DATA 3

DATA 4

DATA 197

15 DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

DATA 1

20 DATA 9

DATA 17

DATA 25

DATA 176

DATA 184

25 DATA 192

DATA 200

DATA 1

DATA 17
DATA 176
DATA 192
DATA 9
5 DATA 25
DATA 184
DATA 200

FIG.58

10 5600 SIGNAL PROCESSING SECTION
5608 DECODING SECTION
5610 INTERLEAVER (PATTERN Y)
5616 INTERLEAVER (PATTERN X)
5614 DECODING SECTION
15 5607 DEINTERLEAVER (FOR PATTERN Y)
5613 DEINTERLEAVER (FOR PATTERN X)
5606 LIKELIHOOD DECISION SECTION
5612 LIKELIHOOD DECISION SECTION
5604 INTERLEAVER (PATTERN X)
20 1301 SIGNAL POINT REDUCTION SECTION
1302 SIGNAL POINT REDUCTION SECTION
5602 SOFT DECISION DECODING SECTION
1303 SIGNAL POINT REDUCTION SECTION
1304 SIGNAL POINT REDUCTION SECTION
25 5601 DEINTERLEAVER (FOR PATTERN X)
501 SEPARATION SECTION

FIG. 59

(A)

CORRECT SYMBOL

CORRECT SYMBOL

5 WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

10 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

REDUCTION OF SIGNAL POINTS

15 (B)

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

20 WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

25 CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG. 60

(A)

CORRECT SYMBOL

5 CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

WRONG SYMBOL

CORRECT SYMBOL

10 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

TIME

15 REDUCTION OF SIGNAL POINTS

(B)

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

20 CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

25 WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION

TIME

Sa1, Sa3 AND Sb1, Sb3 DECODING

FIG.61

(A)

5 BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

10 DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING.

15 DATA 1

DATA 6

DATA 11

DATA 16

DATA 185

20 DATA 190

DATA 195

DATA 200

DATA 1

DATA 11

25 DATA 185

DATA 195

DATA 6

DATA 16

DATA 190

DATA 200

(B)

5 BEFORE INTERLEAVING

DATA 1

DATA 2

DATA 3

DATA 4

10 DATA 197

DATA 198

DATA 199

DATA 200

AFTER INTERLEAVING

15 DATA 1

DATA 9

DATA 17

DATA 25

DATA 176

20 DATA 184

DATA 192

DATA 200

DATA 1

DATA 17

25 DATA 176

DATA 192

DATA 9

DATA 25

DATA 184

DATA 200

- 5 FIG.62
- 6000 SIGNAL PROCESSING SECTION
- 2405A INTERLEAVER
- 2405B INTERLEAVER
- 512 SOFT DECISION SECTION
- 10 518 SOFT DECISION SECTION
- 2403A DEINTERLEAVER
- 2404A DEINTERLEAVER
- 2403B DEINTERLEAVER
- 2404B DEINTERLEAVER
- 15 2402A INTERLEAVER
- 2402B INTERLEAVER
- 1301 SIGNAL POINT REDUCTION SECTION
- 1302 SIGNAL POINT REDUCTION SECTION
- 6002 HARD DECISION DECODING SECTION
- 20 6003 HARD DECISION DECODING SECTION
- 1303 SIGNAL POINT REDUCTION SECTION
- 1304 SIGNAL POINT REDUCTION SECTION
- 2401A DEINTERLEAVER
- 2401B DEINTERLEAVER
- 25 6001 MAXIMUM LIKELIHOOD DETECTION SECTION

FIG.63

- 6100 MULTI-ANTENNA TRANSMISSION APPARATUS
- 4701 SIGNAL SEPARATION SECTION
- 4704 CODING SECTION FOR (Sa0, Sa2)
- 4706 CODING SECTION FOR (Sa1, Sa3)
- 5 4708 INTERLEAVER (PATTERN X)
- 6101 INTERLEAVER (PATTERN X)
- 202A MODULATION SECTION
- 203A SPREADING SECTION
- 204A RADIO SECTION
- 10 4712 SIGNAL SEPARATION SECTION
- 4715 CODING SECTION FOR (Sb0, Sb2)
- 4717 CODING SECTION FOR (Sb1, Sb3)
- 4719 INTERLEAVER (PATTERN Y)
- 6102 INTERLEAVER (PATTERN Y)
- 15 202B MODULATION SECTION
- 203B SPREADING SECTION
- 204B RADIO SECTION
- 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION
- 20 FIG. 64
- 6200 MULTI-ANTENNA TRANSMISSION APPARATUS
- TRANSMISSION DATA (m1, m2, ..., mk)
- 6201A LDPC CODER (GENERATION MATRIX G_a INSPECTION MATRIX H_a)
- 25 202A MODULATION SECTION
- 203A SPREADING SECTION
- 204A RADIO SECTION

TRANSMISSION DATA (n_1, n_2, \dots, n_k)

6201B LDPC CODER (GENERATION MATRIX G_b INSPECTION MATRIX H_b)

202B MODULATION SECTION

5 203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.65

10 6300 SIGNAL PROCESSING SECTION

6303 PROBABILITY DOMAIN Sum-product DECODING SECTION

6304 PROBABILITY DOMAIN Sum-product DECODING SECTION

509 NUMBER OF SIGNAL POINTS: 4

511 NUMBER OF SIGNAL POINTS: 4

15 515 NUMBER OF SIGNAL POINTS: 4

517 NUMBER OF SIGNAL POINTS: 4

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION

6301 PROBABILITY DOMAIN Sum-product DECODING SECTION

20 6302 PROBABILITY DOMAIN Sum-product DECODING SECTION

1303 SIGNAL POINT REDUCTION SECTION

1304 SIGNAL POINT REDUCTION SECTION

502 NUMBER OF SIGNAL POINTS: 4

505 NUMBER OF SIGNAL POINTS: 4

25 501 SEPARATION SECTION

h12 NUMBER OF SIGNAL POINTS: 16

R2-2 NUMBER OF SIGNAL POINTS: 16

FIG.66

6201A LDPC CODER
6601 INTERLEAVER
5 6201B LDPC CODER

FIG.67

MODULATED SIGNAL A
6801A CHANNEL ESTIMATION SYMBOL
10 6802A DATA SYMBOL
1 FRAME
MODULATED SIGNAL B
6804 CONTROL INFORMATION SYMBOL
6801B CHANNEL ESTIMATION SYMBOL
15 6802B DATA SYMBOL
TIME

FIG.68

6902A ERROR DECISION SECTION
20 6902B ERROR DECISION SECTION
6904 RETRANSMISSION REQUESTING SECTION
6907 DATA GENERATION SECTION
6909 TRANSMISSION SECTION

25 FIG.69

7001 CHANNEL ESTIMATION SYMBOL
7002 DATA SYMBOL

7003 RETRANSMISSION REQUEST INFORMATION SYMBOL
TIME

FIG. 70

- 5 7000 MULTI-ANTENNA TRANSMISSION APPARATUS
 - 7107A DATA STORAGE SECTION
 - 7109A DATA SELECTION SECTION
 - 201A CODING SECTION
 - 202A MODULATION SECTION
 - 10 203A SPREADING SECTION
 - 204A RADIO SECTION
 - 7107B DATA STORAGE SECTION
 - 7109B DATA SELECTION SECTION
 - 201B CODING SECTION
 - 15 202B MODULATION SECTION
 - 203B SPREADING SECTION
 - 204B RADIO SECTION
 - 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION
 - 7103 RECEPTION SECTION
 - 20 7105 RETRANSMISSION REQUEST DETECTION SECTION

FIG. 71

BASE STATION

TERMINAL

- 25 MODULATED SIGNAL A
- MODULATED SIGNAL B

<1>

DATA 1A
DATA 1B
<2>
NO RETRANSMISSION REQUEST
5 <3>
DATA 2A
DATA 2B
<4>
RETRANSMISSION REQUEST
10 <5>
DATA 2A
<6>
NO RETRANSMISSION REQUEST
<7>
15 DATA 3A
DATA 3B
<8>
RETRANSMISSION REQUEST
<9>
20 DATA 3B
<10>
RETRANSMISSION REQUEST
<11>
DATA 3A
25 TIME

FIG. 72

7200 MULTI-ANTENNA RECEPTION APPARATUS
7305 SIGNAL PROCESSING SECTION
404 SIGNAL PROCESSING SECTION
7303 CHANNEL INFORMATION/RECEIVED SIGNAL STORAGE
5 SECTION
7304 RETRANSMISSION INFORMATION DETECTION SECTION
403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A
403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF
10 MODULATED SIGNAL B
403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A
403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B
15 7301 CONTROL INFORMATION DETECTION SECTION
402-1 DESPREADING SECTION
402-2 DESPREADING SECTION
401-1 RADIO SECTION
401-2 RADIO SECTION

20

FIG. 73

7305 SIGNAL PROCESSING SECTION
7401 DATA SELECTION SECTION
512 SOFT DECISION SECTION
25 518 SOFT DECISION SECTION
509 NUMBER OF SIGNAL POINTS: 4
511 NUMBER OF SIGNAL POINTS: 4

515 NUMBER OF SIGNAL POINTS: 4
517 NUMBER OF SIGNAL POINTS: 4
508 SIGNAL POINT REDUCTION SECTION
510 SIGNAL POINT REDUCTION SECTION
5 514 SIGNAL POINT REDUCTION SECTION
516 SIGNAL POINT REDUCTION SECTION
R1-2 NUMBER OF SIGNAL POINTS: 16
R2-2 NUMBER OF SIGNAL POINTS: 16

10 FIG.74
DATA STORED BY RECEPTION APPARATUS
TIME

FIG.75

15 BASE STATION
TERMINAL
MODULATED SIGNAL A
MODULATED SIGNAL B

<1>

20 DATA 1A

DATA 1B

<2>

NO RETRANSMISSION REQUEST

<3>

25 DATA 2A

DATA 2B

<4>

RETRANSMISSION REQUEST

<5>

DATA 2A

DATA 2B

5 <6>

RETRANSMISSION REQUEST

<7>

DATA 2A

<8>

10 NO RETRANSMISSION REQUEST

<9>

DATA 3A

DATA 3B

TIME

15

FIG. 76

BASE STATION

TERMINAL

MODULATED SIGNAL A

20 MODULATED SIGNAL B

<1>

DATA 1A

DATA 2A

DATA 3A

25 DATA 4A

DATA 1B

DATA 2B

DATA 3B

DATA 4B

<2>

RETRANSMISSION REQUEST

5 <3>

DATA 2A

DATA 4A

<4>

RETRANSMISSION REQUEST

10 <5>

DATA 2B

<6>

NO RETRANSMISSION REQUEST

<7>

15 DATA 5A

DATA 6A

DATA 7A

DATA 8A

DATA 5B

20 DATA 6B

DATA 7B

DATA 8B

TIME

25 FIG. 77

TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

TIME

FIG. 78

7700 MULTI-ANTENNA TRANSMISSION APPARATUS

5 7107A DATA STORAGE SECTION

7109A DATA SELECTION SECTION

201A CODING SECTION

202A MODULATION SECTION

203A SPREADING SECTION

10 204A RADIO SECTION

7107B DATA STORAGE SECTION

7109B DATA SELECTION SECTION

201B CODING SECTION

202B MODULATION SECTION

15 203B SPREADING SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

7103 RECEPTION SECTION

7105 RETRANSMISSION REQUEST DETECTION SECTION

20

FIG. 79

X: RECEIVED SIGNAL POINT

●: CANDIDATE SIGNAL POINT WHICH BECOMES $a_0=0$

△: CANDIDATE SIGNAL POINT WHICH BECOMES $a_0=1$

25

FIG. 80

MODULATED SIGNAL A

8901 CONTROL INFORMATION SYMBOL
 8902 CHANNEL ESTIMATION SYMBOL
 8903 DATA SYMBOL
 70 SYMBOLS
 5 MODULATED SIGNAL B
 8902 CHANNEL ESTIMATION SYMBOL
 8903 DATA SYMBOL
 TIME
 MODULATED SIGNAL A
 10 8901 CONTROL INFORMATION SYMBOL
 8902 CHANNEL ESTIMATION SYMBOL
 8903 DATA SYMBOL
 8905 SPECIFIC SYMBOL
 8903 DATA SYMBOL
 15 8905 SPECIFIC SYMBOL
 8903 DATA SYMBOL
 22 SYMBOLS
 2 SYMBOLS
 22 SYMBOLS
 20 2 SYMBOLS
 22 SYMBOLS
 MODULATED SIGNAL B
 8902 CHANNEL ESTIMATION SYMBOL
 8903 DATA SYMBOL
 25 8905 SPECIFIC SYMBOL
 8903 DATA SYMBOL
 8905 SPECIFIC SYMBOL

8903 DATA SYMBOL
TIME
MODULATED SIGNAL A
8901 CONTROL INFORMATION SYMBOL
5 8902 CHANNEL ESTIMATION SYMBOL
8903 DATA SYMBOL
8905 SPECIFIC SYMBOL
8903 DATA SYMBOL
8905 SPECIFIC SYMBOL
10 8903 DATA SYMBOL
8905 SPECIFIC SYMBOL
8903 DATA SYMBOL
16 SYMBOLS
2 SYMBOLS
15 16 SYMBOLS
2 SYMBOLS
16 SYMBOLS
2 SYMBOLS
16 SYMBOLS
20 MODULATED SIGNAL B
8902 CHANNEL ESTIMATION SYMBOL
8903 DATA SYMBOL
8905 SPECIFIC SYMBOL
8903 DATA SYMBOL
25 8905 SPECIFIC SYMBOL
8903 DATA SYMBOL
8905 SPECIFIC SYMBOL

8903 DATA SYMBOL

TIME

FIG. 81

5 BASE STATION

TERMINAL

MODULATED SIGNAL A

MODULATED SIGNAL B

<1>

10 DATA 1A

DATA 1B

<2>

NO RETRANSMISSION REQUEST

<3>

15 DATA 2A

DATA 2B

<4>

RETRANSMISSION REQUEST

<5>

20 DATA 2A

DATA 2B

<6>

NO RETRANSMISSION REQUEST

<7>

25 DATA 3A

DATA 3B

<8>

RETRANSMISSION REQUEST

<9>

DATA 3A

DATA 3B

5 <10>

RETRANSMISSION REQUEST

<11>

DATA 3A

DATA 3B

10 TIME

FIG.82

404 SIGNAL PROCESSING SECTION

403-1A CHANNEL FLUCTUATION ESTIMATION SECTION OF
15 MODULATED SIGNAL A

403-1B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B

403-2A CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL A

20 403-2B CHANNEL FLUCTUATION ESTIMATION SECTION OF
MODULATED SIGNAL B

7301 CONTROL INFORMATION DETECTION SECTION

402-1 DESPREADING SECTION

402-2 DESPREADING SECTION

25 401-1 RADIO SECTION

401-2 RADIO SECTION

FIG.83

- 7900 MULTI-ANTENNA TRANSMISSION APPARATUS
- 201A CODING SECTION
- 2301A INTERLEAVER
- 5 202A MODULATION SECTION
- 203A SPREADING SECTION
- 204A RADIO SECTION
- 202B MODULATION SECTION
- 203B SPREADING SECTION
- 10 204B RADIO SECTION
- 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.84

- 8000 SIGNAL PROCESSING SECTION
- 15 2405A INTERLEAVER
- 512 SOFT DECISION SECTION
- 2403A DEINTERLEAVER
- 2402A INTERLEAVER
- 1301 SIGNAL POINT REDUCTION SECTION
- 20 1302 SIGNAL POINT REDUCTION SECTION
- 503 SOFT DECISION SECTION
- 1303 SIGNAL POINT REDUCTION SECTION
- 1304 SIGNAL POINT REDUCTION SECTION
- 2401A DEINTERLEAVER
- 25 501 SEPARATION SECTION

FIG.85-1

(A)

DATA SEQUENCE

DATA TRANSMITTED BY CHANNEL A

DATA TRANSMITTED BY CHANNEL B

5 (B)

DATA SEQUENCE

(C)

CHANNEL A

TIME

10 CHANNEL B

TIME

(D)

CORRECT SYMBOL

CORRECT SYMBOL

15 CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

WRONG SYMBOL

WRONG SYMBOL

20 WRONG SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

CORRECT SYMBOL

25 TIME

(E)

CORRECT SYMBOL

CORRECT SYMBOL
CORRECT SYMBOL
WRONG SYMBOL
CORRECT SYMBOL
5 CORRECT SYMBOL
WRONG SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
CORRECT SYMBOL
10 WRONG SYMBOL
CORRECT SYMBOL
TIME
REPLICA OF DATA TRANSMITTED BY CHANNEL A
REPLICA OF DATA TRANSMITTED BY CHANNEL B
15
FIG. 85-2
(F)
WRONG SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
20 CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
25 CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
WRONG SIGNAL POINT SELECTION

CORRECT SIGNAL POINT SELECTION
CORRECT SIGNAL POINT SELECTION
TIME

(G)

- 5 WRONG SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 WRONG SIGNAL POINT SELECTION
- 10 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 WRONG SIGNAL POINT SELECTION
- 15 CORRECT SIGNAL POINT SELECTION
 CORRECT SIGNAL POINT SELECTION
 TIME

(H)

- CORRECT SYMBOL
- 20 CORRECT SYMBOL
 CORRECT SYMBOL
 CORRECT SYMBOL
 CORRECT SYMBOL
 CORRECT SYMBOL
- 25 CORRECT SYMBOL
 CORRECT SYMBOL
 CORRECT SYMBOL

CORRECT SYMBOL
 CORRECT SYMBOL
 CORRECT SYMBOL
 TIME

5

FIG.86

8200 MULTI-ANTENNA TRANSMISSION APPARATUS

201A CODING SECTION

2301A INTERLEAVER

10 202A MODULATION SECTION

204A RADIO SECTION

202B MODULATION SECTION

204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

15

FIG.87

TRANSMITTED BY AN1

TRANSMITTED BY AN2

TRANSMITTED BY AN1

20 TRANSMITTED BY AN2

TRANSMITTED BY AN1

TRANSMITTED BY AN2

CHANNEL A

CHANNEL B

25 CHANNEL A

CHANNEL B

CHANNEL A

CHANNEL B
DATA SEQUENCE

FIG. 88

5 TRANSMITTED BY AN1
TRANSMITTED BY AN2
TRANSMITTED BY AN1
TRANSMITTED BY AN2
TRANSMITTED BY AN1
10 TRANSMITTED BY AN2
DATA SEQUENCE

FIG. 89

DATA #1 ...
15 DATA SEQUENCE
RENAMING
(B)
DATA #A1 ...
DATA SEQUENCE

20

FIG. 90

(A)
CHANNEL A
DATA #A1 ...
25 CHANNEL B
DATA #B8 ...
FREQUENCY

CARRIER 1 ...
(B)
CHANNEL A
DATA #A6 ...
5 CHANNEL B
DATA #B8 ...
FREQUENCY
CARRIER 1 ...
(C)
10 CHANNEL A
DATA #A ...
CHANNEL B
DATA #B6 ...
FREQUENCY
15 CARRIER 1 ...
(D)
CHANNEL A
DATA #A6 ...
CHANNEL B
20 DATA #B10 ...
FREQUENCY
CARRIER 1 ...

FIG.91

25 8400 MULTI-ANTENNA TRANSMISSION APPARATUS
201A CODING SECTION
8401A INTERLEAVER

202A MODULATION SECTION
 204A RADIO SECTION
 8401B INTERLEAVER
 202B MODULATION SECTION
 5 204B RADIO SECTION
 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.92.

8300 MULTI-ANTENNA TRANSMISSION APPARATUS
 10 201A CODING SECTION
 2301A INTERLEAVER
 202A MODULATION SECTION
 8301A SIGNAL-TO-SUBCARRIER ASSIGNMENT SECTION
 204A RADIO SECTION
 15 202B MODULATION SECTION
 8301B SIGNAL-TO-SUBCARRIER ASSIGNMENT SECTION
 204B RADIO SECTION
 210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

20 FIG.93

(A)

TRANSMISSION DATA ON CHANNEL A

TRANSMISSION DATA ON CHANNEL B

(B)

25 CODED SYMBOL BLOCK

DATA SEQUENCE

(C)

CODED SYMBOL BLOCK

DATA SEQUENCE

(D)

DATA SEQUENCE

5 (E)

DATA SEQUENCE

(F)

CARRIER 1 ...

(G)

10 CARRIER 1 ...

FIG.94

DEINTERLEAVING

TRANSMISSION DATA ON CHANNEL A

15 TRANSMISSION DATA ON CHANNEL B

ERROR CORRECTION

FIG.95

9000 MULTI-ANTENNA TRANSMISSION APPARATUS

20 201A CODING SECTION

2301A INTERLEAVER

202A MODULATION SECTION

203A SPREADING SECTION

204A RADIO SECTION

25 2301B INTERLEAVER

202B MODULATION SECTION

203B SPREADING SECTION

.204B RADIO SECTION

210 FRAME CONFIGURATION SIGNAL GENERATION SECTION

FIG.96

5 (A)

DATA #1 ...

DATA SEQUENCE

AFTER INTERLEAVING

(B)

10 CHANNEL A

DATA #5 ...

CHANNEL B

DATA #12 ...

TIME

15

FIG.97

9200 SIGNAL PROCESSING SECTION

2405A INTERLEAVER

2405B INTERLEAVER

20 512 SOFT DECISION SECTION

2403A DEINTERLEAVER

2404A DEINTERLEAVER

2403B DEINTERLEAVER

2404B DEINTERLEAVER

25 2402A INTERLEAVER

2402B INTERLEAVER

1301 SIGNAL POINT REDUCTION SECTION

1302 SIGNAL POINT REDUCTION SECTION
503 SOFT DECISION SECTION
1303 SIGNAL POINT REDUCTION SECTION
1304 SIGNAL POINT REDUCTION SECTION
5 2401A DEINTERLEAVER
2401B DEINTERLEAVER
501 SEPARATION SECTION

FIG.98

10 (A)
CHANNEL A
DATA #A1 ...
CHANNEL B
DATA #B1 ...
15 DATA SEQUENCE
INTERLEAVING
(B)
CHANNEL A
DATA #A1 ...
20 CHANNEL B
DATA #B1 ...
DATA SEQUENCE
PUNCTURING
(C)
25 CHANNEL A
DATA #A1 ...
CHANNEL B

DATA #B1 ...
DATA SEQUENCE

FIG.99

5 HORIZONTAL
VERTICAL

DATA #A1 ...
DATA #A8 ...
DATA #A50 ...

10

FIG.100

PRESENCE/ABSENCE OF DATA (1: PRESENT 0: ABSENT)
ADDRESS FOR HORIZONTAL DIRECTION
ADDRESS FOR VERTICAL DIRECTION

15 DATA

DATA #A1
...

FIG.101

20 TRANSMISSION DATA SEQUENCE

8601 MODULATION SECTION

8603 VECTOR MULTIPLEXING SECTION

CHANNEL STATE INFORMATION

8602 CHANNEL ANALYSIS SECTION

25 8604 TRANSMISSION ARRAY ANTENNA

TRANSMISSION MULTIBEAMS

PROPAGATION CHANNEL

RECEPTION MULTIBEAMS

8612 RECEPTION ARRAY ANTENNA

8613 MULTIPLEXED SIGNAL SEPARATION SECTION

8611 CHANNEL ANALYSIS SECTION

5 CHANNEL STATE INFORMATION

8614 SIGNAL PROCESSING SECTION

RECEIVED DATA SEQUENCE

FIG.102

10 TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

3 MODULATED SIGNAL GENERATION SECTION

6 RADIO SECTION

13 RADIO SECTION

15 17 RADIO SECTION

19 DEMODULATION SECTION

FIG.103

TRANSMISSION APPARATUS

20 RECEPTION APPARATUS

FIG.104

TRANSMISSION SIGNAL A

TRANSMISSION SIGNAL B

25 TIME